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MECHANICS OF UNIDIRECTIONAL FIBER-REINFORCED COMPOSITES: BUCKLING MODES AND FAILURE UNDER COMPRESSION ALONG FIBERS

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One-dimensional linearized problems on the possible buckling modes of an internal or peripheral layer of unidirectional multilayer composites with rectilinear fibers under compression in the fiber direction are considered. The investigations are carried out using the known Kirchhoff–Love and Timoshenko models for the layers. The binder, modeled as an elastic foundation, is described by the equations of elasticity theory, which are simplified in accordance to the model of a transversely soft layer and are integrated along the transverse coordinate considering the kinematic coupling relations for a layer and foundation layers. Exact analytical solutions of the problems formulated are found, which are used to calculate a composite made of an HSE 180 REM prepreg based on a unidirectional carbon fiber tape. The possible buckling modes of its internal and peripheral layers are identified. Calculation results are compared with experimental data obtained earlier. It is concluded that, for the composite studied, the flexural buckling of layers in the uniform axial compression of specimens along fibers is impossible — the failure mechanism is delamination with buckling of a fiber bundle according to the pure shear mode. It is realized (due to the low average transverse shear modulus) at the value of the ultimate compression stress equal to the average shear modulus. It is shown that such a shear buckling mode can be identified only on the basis of equations constructed using the Timoshenko shear model to describe the deformation process of layers.

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